USN Maritime Surveillance Power requirements for Future Distributed Netted Systems

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Distributed Netted Systems (DNS)

- **What is a Distributed Netted System?**

Outline

- USN & Renewable Energy Sources (RES)
- How RES Change the Game
- Constraints of DNS
- Types of Ocean Energy and associated pitfalls
- Past and Ongoing Industry/Academic Efforts
- Ongoing Search for New Power Solutions

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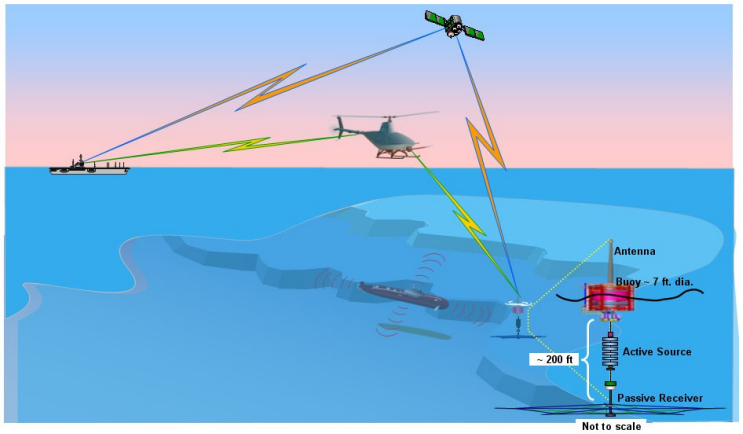
USN & Renewable Energy Sources (RES) It Makes Sense

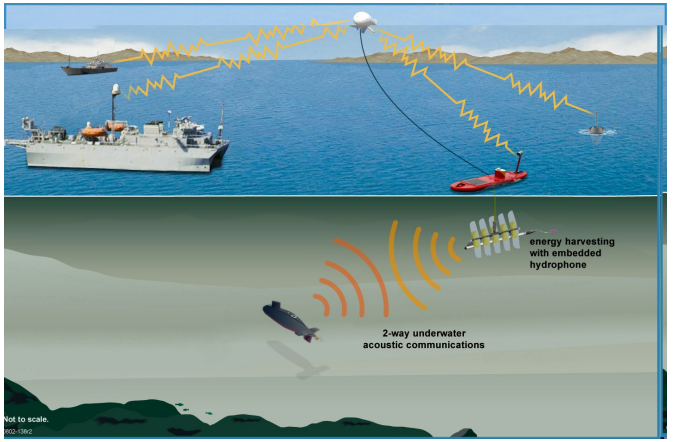
- **Navy Pushing for Renewable Power Sources – Multiple Directives**
  - The Department of the Navy Objectives for FY2008 and Beyond
  - Energy Policy Act of 2005
  - National Defense Authorization Act for Fiscal Year 2007
  - Presidential Executive Order 13423
  - Energy Independence and Security Act of 2007
- **Ocean Energy is a Current Thrust for Consideration**
  - Legislative Definition of Renewable Energy

Renewable Energy sources can be GAME CHANGING for Distributed Netted Systems

How RES Change the Game

- **DNS are Battery Centric**
- **Versus batteries, the hope is that RES yields:**
  - ↓ Cost
  - ↓ Size
  - ↓ Weight
  - ↓ Certification Cost
  - ↓ Disposal Costs
  - ↑ Life
  - ↑ Safety





Power is the limiting factor in DNS lifespans

Constraints of DNS

- **Power needed at the Distributed Sensor Node**

Passive	**5 Watts**	**Continuous Power**	**Seafloor Node**	**Months - 1 Year+**
Active	**20 Kilowatts**		**Surface Node**	

- **Inherently, DNS are driven to be:**
  - Disposable
  - Inexpensive
  - Rapidly installed
    - **Compact** for ease of transport/overboarding
  - Resistant to harsh ocean environments/fouling
  - Resistant to Tampering
  - Long Shelf-Life

Types of Ocean Energy

- Wave
- Thermal
- Tidal/Ocean Current
- Wind
- Solar Energy
- Fuel Cells
- New Power Solutions

Ocean Energy - Wave Energy

- **Issues to be addressed - Wave Energy Converters**
  - Narrow frequency response
    - optimal power generation only in specific wave conditions
  - Size of systems
    - grow significantly with amount of power demanded
    - potential hybrid configuration to reduce size
  - Significant surface/water-column presence and moving parts that are highly susceptible to fouling/tampering.

Wave Energy Converters show promise

Ocean Energy - Other

- **Thermal/Tidal/Ocean Current**
  - Require more permanent installations
  - To date: size, weight, deployment issues don't make a good fit for DNS
- **Wind/Solar Energy**
  - Good if there is surface presence
  - Hybrid only
  - Presents a challenge with respect to fouling/tampering
  - Drag Considerations for station keeping

Past and Ongoing Industry/Academic Efforts

- High Energy Density Batteries
- Ocean Power Technologies (OPT) wave energy buoy
- Teledyne Wave Energy Harvester
  - **DARPA / Teledyne**
- Renewable At-Sea Power Program
  - **DARPA / MBARI**
- Microbial Fuel Cells
- Liquid Robotics
  - **Wave Energy to Motion**
- Lithium Sea Water Batteries – Higher energy density, increased safety

New Power Solutions

- **SPAWAR needs industry assistance**
  - Searching for innovative power approaches

- **Variety of Applications**
  - Sensors
  - Unmanned Underwater Vehicles
  - Unmanned Surface Vehicles
  - Station Keeping Buoys

- **Questions?**